REMARKS

The present Preliminary Amendment is submitted to replace claims 1-25 with new claims 26-47. Also, the specification and abstract are amended in a manner similar to that in the parent application Serial No. 09/319,779, thereby placing the application in better condition for examination.

Copies of the amended portion of the specification and abstract with changes marked therein is attached and entitled "Version with markings to show changes made."

The following comments are similar to those presented in the parent application and are presented for the Examiners consideration.

Tagusa discloses that as shown in Figs. 4 and 5, "*the drive IC 1 is provided with L-shaped alignment marks 18a and 18b in portions corresponding to the alignment marks 17a and 17b of the flexible wiring board 40*" on column 13, lines 51-52. That is, the marks 18a and 18b are served as the positions corresponding to the alignment marks 17a and 17b of the flexible wiring board 40, **but cannot serve as the arrangement positions of the electrical connecting portions of the drive IC 1.** Therefore, the arrangement positions of the electrical connecting portions of the IC can **not** be found or detected by observing or detecting the marks 18a and 18b, thus resulting in not solving the issues described in the present application.

Yagi discloses that "The lead wires of the circuit element E which has been subjected to the centering and turning treatment are observed by the camera 90 of the lead wire detection mechanism and a picture obtained is supplied to a position correcting operation unit or picture processing unit." on column 7, lines 34-39. That is, the lead wire of the circuit element that is located outside of the outline of the element is detected by the camera 90, and this information is used for the centering and turning treatment, **but cannot serve as the arrangement positions of the electrical connecting portions of the element**. Therefore, the arrangement positions of the electrical connecting portions

of the element can **not** be found or detected by observing or detecting the lead wire of the circuit element, thus resulting in not solving the issues described in the present application.

In the present invention, the reference mark is located within the outline of the component and serves as a reference for the **arrangement positions of the electrical connecting portions arranged in dotted or island shape, not the position of the electrical component** in order to solve the issues described in the present invention, that is, recognize the state of arrangement of the electrical connecting portions easily and correctly at high speed in mounting the electronic components such as: a BGA component represented by, for example, CSP having solder bumps for forming an electronic circuit; or a QFP component having no solder bump for forming an electronic circuit and satisfies a reliable component mounting quality of a high productivity.

In view of the above, it is submitted that the present application is in condition for allowance.

Respectfully submitted,

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ABSTRACT

An electronic component, such as a BGA component, and a method of positioning with respect to a mounting head the component. The BGA component is positioned through positional detection of a reference mark and inspection, and the positional correction is executed by checking the holding posture. Through the inspection using the reference mark as a reference position, the dropout, dislocation, shortage of solder amount of the solder bumps of the component are subject to a quality check (S4). If of normal quality, the component is moved closer to the mounting position of the printed board on a mounting table by a mounting head (S5). A recognition mark in the target mounting position of the printed board is confirmed and recognized (S6). By determining the mounting position through mounting position detection and component inspection result, the mounting position is corrected (S7) and the height of the mounting head is controlled and the component is mounted (S8).

DESCRIPTION

Version with Markings to Show Changes Made

ELECTRONIC COMPONENT AND MOUNTING METHOD AND APPARATUS THEREOF

This is a divisional application of Serial No. 09/319,779, filed June 11, 1999.

BACKGROUND OF THE INVENTION

~~TECHNICAL FIELD~~

1. Technical Field

The present invention relates to an electronic component having electrical connecting portions such as solder bumps or electrodes (lands, for example) exemplified by a solder bump component of a BGA (Ball Grid Array) type semiconductor component package (referred to as a BGA component hereinafter) represented by a CSP (Chip Size Package) or an electronic component such as QFP in forming an electronic circuit and relates to the mounting method and apparatus thereof.

which is a national stage application of International Application PCT/JP97/04578 filed December 12, 1997.

~~BACKGROUND ART~~

2. Description of Related Art

In recent years, personal computers, portable telephones, information communications devices, multimedia electronic equipment, and the like have been compacted and provided with improved functions. Further, the electronic components and printed boards constituting electronic circuits have been made to have higher densities and finer constructions due to higher frequencies, and the mounting of components having a plurality of pins go mainstream in conformity to high-density circuits of QFP (Quad Flat Package) and the like. However, on increasing the density, the lead pitch of the connecting portions has been reduced in stages, for example, from 0.5 mm through 0.3 mm to the

portions easily and correctly at high speed in mounting the electronic components such as: a BGA component represented by, for example, CSP having solder bumps for forming an electronic circuit; or a QFP component having no solder bump for forming an electronic circuit and satisfies a reliable component mounting quality of a high productivity.

(1) ~~DISCLOSURE~~ SUMMARY OF THE INVENTION

The present invention is constructed as follows to achieve the aforementioned object.

According to a first aspect of the present invention, there is provided an electronic component to be mounted on a printed board, characterized by comprising:

a plurality of electrical connecting portions provided on an electrical connecting surface of the electronic component and the printed board; and a reference mark that serves as a reference of arrangement positions of the electrical connecting portions.

According to a second aspect of the present invention, there is provided an electronic component according to the first aspect, characterized in that the reference mark of the electronic component is provided on the electrical connecting surface side facing a mounting position on the printed board.

According to a third aspect of the present invention, there is provided an electronic component according to the first aspect, characterized in that the reference mark of the electronic component is provided on

Fig. 16A is a sectional view of a conventional BGA component having solder bumps and a printed board;

Fig. 16B is a bottom view of the BGA component;

Fig. 17 is a partially see-through perspective view of the component mounting apparatus of a prior art example;

Fig. 18 is a partially see-through perspective view of a component mounting apparatus of another prior art example;

Fig. 19 is a sectional view showing the mounting of a BGA component by the conventional component mounting apparatus shown in Fig. 18; and

Figs. 20A through 20J are views showing the BG connecting portion arrangement pattern on the connecting surface of the conventional BGA component.

(16) DETAILED DESCRIPTION OF BEST MODE FOR CARRYING OUT THE INVENTION

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals throughout the accompanying drawings.

A first embodiment of the present invention will be described in detail below with reference to the drawings.

Fig. 1 is a perspective view showing an electronic component and the outline of a component mounting apparatus capable of implementing an electronic component mounting method, according to the first embodiment of the present invention. In this figure, the components that correspond

conveyed to the outside by the conveyance rails 15 after a mounting ending process S10, the steps being described later. Further, the component supplying section 16 of the electronic component mounting apparatus can be mounted with the tape-shaped parts cassette 16a, the bulk cassette 16b for components stored in a scattered form, the plate-shaped parts tray 16', and the like, which serve as a removable component set for continuously supplying the components.

Fig. 2 is a block diagram showing the outline of a control section for executing mounting control of the component mounting apparatus. In Fig. 2, reference numerals denote respectively, 20 a storage section provided with a mounting program storage section 20a and a component data storage section 20b, 21 an input/output control section, 22 a component supply control section, 23 a recognition control section, 24 a positioning control section, 25 a pressure control section, 26 a height control section, and 300 a CPU. The mounting program storage section 20a stores: mounting data such as a mounting sequence, component names, mounting positions (X, Y, θ), and supply positions of components to be supplied; and a program for executing the mounting process. The component data storage section 20b stores information such as component names, component (appearance) shapes (widths, lengths, heights), colors, reference mark positions with respect to component body dimensions (appearance or external ends) or reference mark positions with respect to the centers of the components, patterns

(arrangement positions) of the lands of BG connecting portions with respect to the reference marks, reference mark shapes (the center of gravity and positions of the vertex and the sides in the case of a triangular reference mark; the center of gravity and positions of the corners and the sides in the case of a rectangular reference mark; the center or the center of gravity in the case of a circle or dot reference mark), the ball shape (including sphere, sphere diameter, and so on) in each arrangement position, information of the presence or absence of a ball, and so on. The CPU 300 issues whole mounting commands and instructions to each of the driving units and so on. The input/output control section 21 is to execute input and output of the mounting program and the component data by manual input or by an FD or communications. It is otherwise acceptable to directly execute the input and the output of data of the actual X- and Y-positions, angle, pressure, and the like on the component supply control section 22, the positioning control section 24, the height control section 26, and the pressure control section 25, not by way of the input/output control section 21. The component supply control section 22 drives the component supply section of a tray, a cassette, or the like, and then supplies an appropriate component to a component supply position. The recognition control section 23 executes the recognition of the component, reference marks of the component and the board, IC marks, arrangement patterns, and so on, executes

described with reference to Fig. 14A and Fig. 14B.

On the lower surface of an IC chip 5b are preparatorily formed gold bumps 5d via aluminum electrodes 5c. This IC chip 5b is bonded with pressure via silver paste 5e on upper electrodes 5f of a single-layer or multi-layer carrier board 5a made of glass epoxy or ceramic and then encapsulated with resin to be formed into the complete BGA component 5. The BG connecting portions 6 are to be electrically connected to the upper electrodes 5f by wirings 5g that penetrate the carrier board 5a, and the reference marks 30 are formed simultaneously with each other on this carrier board 5a, as shown in Fig. 13A. Subsequently, the solder bumps 7 are formed. It is to be noted that the solder bumps 7 are not formed in the case of a bump-less component which needs no solder bump 7.

The electrical connecting portions of, for example, the lands and the BG connecting portions 6 often have a circular shape, and therefore, the reference mark 30 preferably has a triangular shape or the like other than the circular shape so as to facilitate the discrimination of the reference mark from the shape. If the triangular shape is adopted, it is easy to specify the direction of the triangle according to the positions of the sides and the positions of the vertexes. For example, if the reference mark 30 is constructed of a mark of one isosceles triangle defined so that the direction parallel to the base different from the equi-length sides is a Y-direction and the direction

mounting position of the printed board 1 on the mounting table 14 in a mounting position determining process (S5).

In a board mounting position recognizing process, the target mounting position recognition marks 30 of the printed board 1 shown in Fig. 3A is confirmed and recognized by the board recognizing section 13b as needed (S6).

In a determination (check) correcting process after the mounting position detection, the mounting position is corrected by securing a high degree of accuracy through the mounting position determination correcting process together with the foregoing component inspection results (S7).

In a component mounting process, the mounting head 13 is lowered under the control of the height control section 26 so as to execute the mounting of the component 5 on the board 1 (S8).

In this stage, the diameters of the spheres are detected according to the inspection results of the sizes, variations, and so on of the solder bumps 7 at the BG connecting portions 6 in the case of the spherical solder bumps. Therefore, it is also allowed to obtain the average height of the BGA component 5 on the basis of the detected diameters, obtain a gap between the BGA component 5 and the printed board 1 through optimization and execute the calculation of the optimum control of the height control section 26 of the mounting head 13 or the optimum control of the pressure control section 25 for pressing the component in mounting as described in connection with the prior art

mounting and for a reduction in time when replacing the faultily mounted component and performing rearrangement in replenishing the component to be mounted.

(14) Fig. 11A is a front view of a two-dimensional bar code provided on the surface opposite from the surface that has BG connecting portions of a BGA component according to a sixth embodiment of the present invention, while Fig. 11B is a side view of the above. The bar code is provided on the surface opposite from the connecting surface described in connection with the fifth embodiment. If the two-dimensional bar code 40 is ~~given to~~ provided on the upper surface of the BGA component 5 and a variety of information for mounting the components, such as the land pitch and positional information of the BG connecting portions of the various components are coded as the indicated information, then the mounting control of the mounting head height, the mounting speed, the mounting pressure control, and so on in the mounting stage can be executed for each component on the basis of the information as the checking and correcting processes in the component recognizing process (process S4) shown in Fig. 4. Furthermore, a two-dimensional bar code 40 having a larger size can be used by providing the bar code on the surface opposite from the connecting surface, and the information carrying area is enlarged to allow a wider variety of information to be provided. This operates favorably in controlling the mounting. If the amounts of deviation from the permissible range and the dropouts of the

(11)

solder bumps are stored as information to be stored in the two-dimensional bar code 40 or another storage medium, then the information can be utilized as information for determining whether or not the component should be scrapped or reused with the solder bump reformed when the BGA component 5 is determined to be defective.

Fig. 12A shows two-dimensional bar code processing through a component inspecting process of a control section, while Fig. 12B is a view for explaining the two-dimensional bar code processing through a board recognizing process. The component inspecting process shown in Fig. 12A obtains the information of the component by two-dimensional bar code detection through the component inspecting process of the recognition control section 23 from a signal read from the component inspecting section 13a, and executes the component recognizing process. Also, in the board recognizing process shown in Fig. 12B, the component information is obtained by detecting the two-dimensional bar code from a signal from the board recognizing section 13b through the board recognizing process in the recognition control section 23. By sharing the two-dimensional bar code detecting process of the board recognizing section 13b and further sharing an optical detector of, for example, a camera or a laser scanner as the component recognizing section 13b for recognizing the reference mark 30 so as to read the two-dimensional bar code 40, the detection of the component inspecting section 13a becomes unnecessary.

This can reduce the mounting cycle time and improve the productivity as compared with the conventional component position detection, so that the component mounting can be achieved faster and more reliably to allow the quality to be improved.

Furthermore, the present invention can achieve the component mounting faster and more reliably by confirming the recognition mark(s) on the printed board in the recognizing process.

Furthermore, according to the present invention, the state of arrangement of the whole BG connecting portions, the shape of each solder bump, the dropout of the solder bump that causes the defective component mounting, and so on can be detected and checked easily and accurately at high speed by the reference mark(s), so that a reliable component mounting quality can be provided.

(17) Furthermore, according to the present invention, the information of the coded reference mark(s) can assure an (19) inexpensive and simple structure, without the necessity of providing no (20) a separate special device for executing detection, by virtue of the detection that is achieved and is also used for the recognition process.

Furthermore, according to the present invention, the component type in the electronic component mounting position can be confirmed to prevent the faulty mounting by virtue of the fact that at least one of the recognition marks on the printed board is the discrimination information

ABSTRACT

Processing is started (S1), and control of mounting processes is successively executed by mounting program instructions of a storage section (S2). An electronic component is positioned with respect to a mounting head ~~taken out, and held (S3)~~. The BGA component is positioned through positional detection of a reference mark and inspection, and the ~~correcting~~ is executed by checking the holding posture. Through the inspection using the reference mark as a reference position, the dropout, dislocation, shortage of solder amount of the solder bumps of the component are subjected to quality check (S4). ~~The~~ ~~normal~~ component is moved closer to the mounting position of the printed board on a mounting table by a mounting head (S5). A recognition mark in the target mounting position of the printed board is confirmed and recognized (S6). By determining the mounting position through mounting position detection and component inspection result, the mounting position is corrected (S7) and the height of the mounting head is controlled and mounted (S8). Depending on the presence or absence of the component to be mounted, the program flow proceeds to the process S1 for continuing the processing or to the process S10 for ending (S9), and the processing ends (S10).